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(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

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TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

L9289.01126

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

New Application 09/806313

INTERNATIONAL APPLICATION NO.
PCT/JP00/04969INTERNATIONAL FILING DATE
July 26, 2000PRIORITY DATE CLAIMED
August 20, 1999

TITLE OF INVENTION

OFDM COMMUNICATION APPARATUS

APPLICANT(S) FOR DO/EO/US

Hiroaki SUDO

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Claim for Priority w/PCT/IB/304

PCT/IB/308

PCT/RO/101

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.53) 09/806313 New Application	INTERNATIONAL APPLICATION NO. PCT/JP00/04969	ATTORNEY'S DOCKET NUMBER L9289.01126
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21. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

- ☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **\$1,000.00**
- ☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **\$860.00**
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **\$710.00**
- ☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **\$690.00**
- ☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **\$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =

\$860.00

Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

\$0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	6 - 20 =	0	x \$18.00
Independent claims	6 - 3 =	3	x \$80.00

\$0.00

\$240.00

Multiple Dependent Claims (check if applicable). ☐

\$0.00

TOTAL OF ABOVE CALCULATIONS =

\$1,100.00

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). ☐

\$0.00

SUBTOTAL =

\$1,100.00

Processing fee of **\$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).

\$0.00

TOTAL NATIONAL FEE =

\$1,100.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). ☒

\$40.00

TOTAL FEES ENCLOSED =

\$1,140.00

Amount to be:	\$
refunded	
charged	\$

☒ A check in the amount of **\$1,140.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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NAME

28,732

REGISTRATION NUMBER

March 29, 2001

DATE

DESCRIPTION

OFDM COMMUNICATION APPARATUS

5 Technical Field

The present invention relates to an OFDM
(Orthogonal Frequency Division Multiplexing)-based
communication apparatus carrying out retransmission
control, and more particularly, to an OFDM-based
10 communication apparatus using an interleave technology.

Background Art

Retransmission control by a conventional OFDM
communication apparatus using an interleave technology
15 will be explained with reference to FIG.1. FIG.1 is a
block diagram showing a conventional OFDM communication
apparatus using an interleave technology.
Retransmission control by the conventional OFDM
communication apparatus using an interleave technology
20 will be explained below, taking the following case where
a first communication apparatus and a second
communication apparatus both equipped with the OFDM
communication apparatus shown in FIG.1 perform a radio
communication as an example. What will be explained here
25 is a case where the first communication apparatus sends
a signal to the second communication apparatus and when
the signal received by the second communication
apparatus contains an error, the first communication

apparatus retransmits (resends) this erroneous signal to the second communication apparatus.

First, in the transmission system of the first communication apparatus, a transmission signal is stored
5 in retransmission control section 11. This transmission signal is a packet-unit signal. The stored transmission signal is sent by retransmission control section 11 to interleave processing section 12 according to a transmission timing.

10 In interleave processing section 12, the sequence of the signal sent by retransmission control section 11 is rearranged according to a specific rule. The signal with the rearranged sequence is subjected to predetermined transmission OFDM processing by
15 transmission OFDM section 13 and placed in each subcarrier.

Here, the signal subjected to the predetermined transmission OFDM processing above refers to a signal assigned to each subcarrier at predetermined subcarrier
20 intervals as a result of interleave processing by interleave processing section 12. That is, regarding the signal subjected to the predetermined transmission OFDM processing above, the first to third transmission signals input to interleave processing section 12 are
25 placed at intervals of, for example, 4 subcarriers such as subcarrier 1, subcarrier 5 and subcarrier 9, and so on.

The signal subjected to the transmission OFDM

processing is sent to the second communication apparatus via antenna 14. The signal sent from the first communication apparatus is received by the second communication apparatus through a transmission path.

5 The signal received through antenna 14 by the second communication apparatus is subjected to predetermined reception OFDM processing by reception OFDM section 15. The signal subjected to the predetermined reception OFDM processing above is subjected to deinterleave processing
10 by deinterleave processing section 16. The signal subjected to deinterleave processing is subjected to error correction processing by error correction section 17. The error-corrected signal is output to retransmission control section 11.

15 When the error-corrected signal in retransmission control section 11 contains no error, this signal is output as a reception signal. On the contrary, when the error-corrected signal contains some error, this signal is stored in predetermined memory. Then, a signal
20 including a packet requesting retransmission of this signal is processed by interleave processing section 12 and transmission OFDM section 13 and then sent to the first communication apparatus through antenna 14.

Then, in the first communication apparatus,
25 retransmission control section 11 sends the packet requesting retransmission by the second communication apparatus to interleave processing section 12 according to a retransmission timing. This packet is subjected to

the same processing as that described above and resent to the second communication apparatus through antenna 14.

As shown above, the signal containing an error detected by the second communication apparatus is resent by the first communication apparatus.

However, the conventional OFDM communication apparatus using an interleave technology has the following problems. That is, there are cases where signals of poor quality concentrated on a specific time period are input as the signals subjected to error correction processing in the second communication apparatus.

Here, FIG.2 is used as a reference to explain this situation more specifically. FIG.2 is a schematic diagram showing an example of placement of subcarriers of a signal received by the conventional OFDM communication apparatus using an interleave technology. Suppose interleave processing section 12 in the first communication apparatus performs the interleave processing as shown in the example above.

When the signal with subcarriers placed as shown in FIG.2 is received by the second communication apparatus, the signals output from deinterleave processing section 16 are signals picked up in time series from each subcarrier at intervals of 4 subcarriers such as subcarrier 1, subcarrier 5, subcarrier 9 and subcarrier 13, ... Here, as is apparent from FIG.2,

signals placed in subcarrier 1, subcarrier 5, subcarrier 9 and subcarrier 13, ... are of poor quality.

As a result, signals input to error correction section 17 are signals of poor quality concentrated on a specific time period, which causes the effect of error correction by error correction section 17 to reduce, making signals with errors often output to retransmission control section 11. This causes the first communication apparatus to resend the same packet.

Furthermore, when a variation of the channel (transmission path) state occurs slower than the time interval at which the first communication apparatus sends the same packet, the channel state when the same packet above is sent for the first time becomes virtually the same as the channel state when the above same packet is retransmitted (resent).

In this case, when the signal including the resent packet is received by the second communication apparatus, the state of subcarrier placement in this received signal has virtually the same state as that shown in FIG.2. Therefore, there is an extremely high probability that the packet resent from the first communication apparatus will also have errors in the second communication apparatus, and furthermore errors will occur consecutively in the above packets. This means that it will take a long time for the second communication apparatus to receive a specific packet sent by the first communication apparatus without errors.

Disclosure of Invention

The inventor of the present invention has come up with the present invention noticing that subcarriers to which transmission signals subjected to OFDM transmission processing are assigned change depending on the interleave processing carried out before OFDM transmission processing, and therefore changing the interleave processing on the transmission signal will change the quality of each signal extracted through OFDM reception processing on the receiving side.

It is an object of the present invention to provide an OFDM communication apparatus capable of reducing the probability that errors will occur consecutively in a same packet. This object is attained by performing interleave processing on the transmission signal according to the number of retransmissions of the transmission signal.

Brief Description of Drawings

FIG.1 is a block diagram showing a configuration of a conventional OFDM communication apparatus using an interleave technology;

FIG.2 is a schematic diagram showing an example of subcarrier placement in signals received by an OFDM apparatus using an interleave technology;

FIG.3 is a schematic diagram showing a state of a channel used by the conventional OFDM communication

FIG.4 is a block diagram showing a configuration of an OFDM communication apparatus according to an embodiment of the present invention.

Best Mode for Carrying out the Invention

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FIG.4 is a block diagram showing a configuration of an OFDM communication apparatus according to an embodiment of the present invention. Hereinafter, the OFDM communication apparatus according to this embodiment will be explained by taking a case where a first communication apparatus and second communication apparatus both equipped with this OFDM communication apparatus carry out a radio communication as an example.

25

First, in the transmission system of the first communication apparatus, a transmission signal is stored

in retransmission control section 101. This transmission signal is a packet-unit signal, for example. The stored transmission signal is sent by retransmission control section 101 to first interleave processing section 102 and second interleave processing section 103 according to a preset transmission timing.

First interleave processing section 102 performs interleave processing on the signal sent by retransmission control section 101. That is, the sequence of the signal sent by retransmission control section 101 is rearranged according to a specific rule. The signal with the rearranged sequence is output to selector 104.

Second interleave processing section 103 performs interleave processing on the signal sent by retransmission control section 101. That is, the sequence of the signal sent by retransmission control section 101 is rearranged according to a specific rule. However, the specific rule used by second interleave processing section 103 is different from the specific rule used by first interleave processing section 102. The signal with the sequence rearranged by second interleave processing section 103 is output to selector 104.

As the interleave method by first interleave processing section 102 and second interleave processing section 103, various kinds of interleave including chip interleave and symbol interleave can be used.

Under the control by retransmission control section 101, selector 104 outputs the interleaved signal output from either first interleave processing section 102 or second interleave processing section 103 to transmission OFDM section 105.

More specifically, a control signal is output from retransmission control section 101 to selector 104, which indicates which of the interleaved signal, from first interleave processing section 102 or from second interleave processing section 103, should be output to transmission OFDM section 105 depending on whether the packet sent by retransmission control section 101 is a signal which will be transmitted for the first time or a signal which will be retransmitted.

In this embodiment, it is assumed that when the packet sent by retransmission control section 101 is a signal which will be transmitted for the first time, selector 104 outputs the interleaved signal from first interleave processing section 102 to transmission OFDM section 105 and when the packet sent by retransmission control section 101 is a signal which will be retransmitted, selector 104 outputs the interleaved signal from second interleave processing section 103.

The signal from selector 104, that is, the signal interleaved by first interleave processing section 102 is subjected to predetermined transmission OFDM processing and assigned to subcarriers by transmission OFDM section 105. This transmission OFDM processing

includes processing such as serial/parallel conversion, primary modulation (QPSK and 16QAM, etc.) and IFFT (Inverse Fourier Transform).

Here, the signal subjected to the predetermined transmission OFDM processing above refers to a signal assigned to each subcarrier at predetermined subcarrier intervals as a result of interleave processing by first interleave processing section 102. That is, regarding the signal subjected to the predetermined transmission OFDM processing above, the first to fourth transmission signals input to first interleave processing section 102 are placed at intervals of, for example, 4 subcarriers such as subcarrier 1, subcarrier 5 and subcarrier 9, and so on.

The signal subjected to the transmission OFDM processing is transmitted to the second communication apparatus via antenna 106. The signal sent from the first communication apparatus is received by the second communication apparatus through a transmission path.

The signal received through antenna 106 in the second communication apparatus is subjected to predetermined reception OFDM processing by reception OFDM section 107. This reception OFDM processing includes synchronization, FFT (Fourier Transform), transmission diversity, coherent detection (or delay detection) and parallel/serial conversion, etc. The signal subjected to the predetermined reception OFDM processing above is output to first deinterleave

processing section 108 and second deinterleave processing section 109.

First deinterleave processing section 108 rearranges the sequence of the signal from reception OFDM section 107 according to a specific rule. This specific rule corresponds to the specific rule used by first interleave processing section 102 in the first communication apparatus. Through this rearrangement, the sequence of the signal from reception OFDM section 107 is rearranged to match the sequence when this signal is sent by retransmission control section 101 in the first communication apparatus. The signal deinterleaved by first deinterleave processing section 108 is output to selector 110.

Second deinterleave processing section 109 rearranges the sequence of the signal from reception OFDM section 107 according to a specific rule. This specific rule corresponds to the specific rule used by second interleave processing section 103 in the first communication apparatus. Through this rearrangement, the sequence of the signal from reception OFDM section 107 is rearranged to match the sequence when this signal is sent by retransmission control section 101 in the first communication apparatus. The signal deinterleaved by second deinterleave processing section 109 is output to selector 110.

Under the control by retransmission control section 101, selector 110 outputs the deinterleaved

signal output from either first deinterleave processing section 108 or second deinterleave processing section 109 to error correction section 111.

More specifically, a control signal is output from retransmission control section 101 to selector 110, which indicates which of the deinterleaved signal, from first deinterleave processing section 108 or from second deinterleave processing section 109, should be output to error correction section 111 depending on what times the packet was received through antenna 106, that is, depending on whether the packet received through antenna 106 is a signal which was transmitted for the first time or a signal which was retransmitted by the first communication apparatus.

In this embodiment, it is assumed that when the packet received through antenna 106 is a signal which was transmitted by the first communication apparatus for the first time, selector 110 outputs the deinterleaved signal from first deinterleave processing section 108 to error correction section 111 and when the packet received through antenna 106 is a signal which was retransmitted by the first communication apparatus, selector 110 outputs the deinterleaved signal from second deinterleave processing section 109.

The signal from selector 110, that is, the signal deinterleaved by first deinterleave processing section 108 is subjected to error correction processing by error correction section 111 and output as a packet-unit signal

to retransmission control section 101.

When the error-corrected packet-unit signal contains no error, retransmission control section 101 outputs this signal as a reception signal. On the contrary, when the error-corrected packet-unit signal contains some error, this packet-unit signal is stored in predetermined memory. Hereafter, a signal including a packet requesting retransmission of this packet-unit signal is processed by each section of the transmission system and then transmitted to the first communication apparatus through antenna 106.

Hereafter, in the first communication apparatus that has received the signal including the packet requesting retransmission above, retransmission control section 101 sends the packet-unit signal whose retransmission is requested by the second communication apparatus to first interleave processing section 102 and second interleave processing section 103 according to a retransmission timing. Furthermore, retransmission control section 101 outputs to selector 104 a control signal requesting that the interleaved signal from second interleave processing section 103 be output to transmission OFDM section 105.

According to the above control signal, selector 104 outputs the interleaved signal from second interleave processing section 103 to transmission OFDM section 105. That is, the packet-unit signal to be retransmitted is subjected to interleave processing different from the

interleave processing when the signal is sent for the first time and output to transmission OFDM section 105. The signal from selector 104 is subjected to the aforementioned processing by transmission OFDM section 5 105 and transmitted to the second communication apparatus through antenna 106.

Here, the signal subjected to the transmission OFDM processing of the packet to be retransmitted refers to a signal assigned to each subcarrier at predetermined 10 subcarrier intervals different from the ones in the first transmission as a result of interleave processing by second interleave processing section 103. That is, regarding the signal subjected to the transmission OFDM processing above, the first to fourth signals input to 15 second interleave processing section 103 are placed at intervals of, for example, 2 subcarriers such as subcarrier 1, subcarrier 3 and subcarrier 5, and subcarrier 7, and so on. Because of this, each signal in the packet to be retransmitted is assigned to a 20 subcarrier different from the one in the first transmission.

The second communication apparatus receives the signal including the retransmitted packet through antenna 106. The signal received through antenna 106 is 25 subjected to the same processing as that described above by each of reception OFDM section 107, first deinterleave processing section 108 and second deinterleave processing section 109.

Retransmission control section 101 outputs to selector 110 a control signal requesting that the signal subjected to deinterleave processing from second deinterleave section 109 be output to error correction section 111.

According to the above control signal, selector 110 outputs the signal subjected to deinterleave processing from second deinterleave processing section 109 to error correction section 111. That is, the retransmitted packet-unit signal is subjected to deinterleave processing different from the deinterleave processing when the signal is sent for the first time and output to error correction section 111. The signal from selector 110 is subjected to error correction processing by error correction section 111 and output to retransmission control section 101.

Here, when interleaving processing differing between the first transmission and retransmission is applied to a specific packet in the first communication apparatus, how the signal including this retransmitted packet is received by the second communication apparatus will be explained with reference to FIG.2 again.

As shown in FIG.2, when a specific packet is received by the second communication apparatus for the first time, the signal output from reception OFDM section 107 is the signal picked up by each subcarrier in time series at intervals of 4 subcarriers such as subcarrier 1, subcarrier 5, subcarrier 9 and subcarrier 13, ... As

is apparent from FIG.2, since the signals assigned to subcarrier 1, subcarrier 5, subcarrier 9 and subcarrier 13, ... have poor signal quality, the signals picked up in this way contain errors concentrated on a specific time period.

On the other hand, when the above specific packet is received by the second communication apparatus again, the signal output from reception OFDM section 107 is the signal picked up by each subcarrier in time series at intervals of 2 subcarriers such as subcarrier 1, subcarrier 3, subcarrier 5 and subcarrier 7, ... Suppose, however, the channel state when the above specific packet is received by the second communication apparatus for the first time is virtually the same as the channel state when the above specific packet is received again.

As is apparent from FIG.2, the signals picked up in this way include signals of poor quality and signals of good quality inserted alternately, and therefore these are signals with a low probability that errors will be concentrated on a specific time period. That is, since signals in a specific packet of the first communication apparatus are transmitted after being assigned to subcarriers which differ when this specific packet is transmitted for the first time and when the packet is retransmitted, the quality of each signal in the above specific packet received by the second communication apparatus differs from one case to another. Here, since the channel states in the above cases are

virtually the same, the probability that errors will be concentrated on a specific time period is low in the above specific packet received by the second communication apparatus.

5 Therefore, when there is almost no change in the channel state between the first transmission and retransmission of the specific packet by the first communication apparatus, the probability that errors will occur in the packet retransmitted to the second
10 communication apparatus by the first communication apparatus is extremely low. That is, in the above case, it is possible to avoid cases where errors will occur consecutively in a specific packet.

 This embodiment describes the case where two
15 interleave processing sections and two deinterleave processing sections are provided, but the present invention is not limited to this and is also applicable to a case where more interleave processing sections and more deinterleave processing sections are provided. In
20 this case, it is possible to use a plurality of interleave processing sections and deinterleave processing sections provided according to the number of retransmissions of the packet to be sent. This can reduce, with increased certainty, the probability that
25 errors will occur consecutively in the same packet.

 Furthermore, this embodiment describes the case where the first communication apparatus sends a signal to the second communication apparatus and when an error

is found in the signal received by the second communication apparatus, this signal with the error is retransmitted (resent) from the first communication apparatus to the second communication apparatus.

5 However, since both the first communication apparatus and the second communication apparatus have the configuration shown in FIG.4, the present invention is also applicable to a case where the second communication apparatus sends a signal to the first communication
10 apparatus and when an error is found in the signal received by the first communication apparatus, this signal with the error is retransmitted (resent) from the second communication apparatus to the first communication apparatus.

15 As shown above, this embodiment provides a plurality of interleave processing sections that perform mutually different interleave and a plurality of deinterleave processing sections that perform mutually different deinterleave and uses the above plurality of
20 interleave processing sections and deinterleave processing sections, that is changes the interleave method according to the number of retransmissions of a packet to be sent, thus making it possible to reduce the probability that errors will occur consecutively in the
25 same packet. When an error occurs in a specific packet, this will shorten the time required until this specific packet is received without errors.

This embodiment describes the case where

interleave processing is changed according to the number of retransmissions of a certain packet, but the present invention is not limited to this and is also applicable to a case where a plurality of interleave processing sections and deinterleave processing sections are used differently according to various conditions such as channel quality. This makes it possible to reduce the probability that errors will occur in the received packet.

10 The OFDM communication apparatus according to the embodiment of the present invention can be mounted on a communication terminal apparatus and base station apparatus in a digital mobile communication system.

As described above, the present invention applies
15 interleave processing to a transmission signal according to the number of retransmissions of the transmission signal, making it possible to provide an OFDM communication apparatus capable of reducing the probability that errors will occur consecutively in a
20 same packet.

This application is based on the Japanese Patent Application No. HEI 11-233909 filed on August 20, 1999, entire content of which is expressly incorporated by
25 reference herein.

Industrial Applicability

The present invention is ideally applicable to the

field of an OFDM-based communication apparatus that carries out retransmission control.

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of deinterleave processing means and allowing the selected interleave means to execute deinterleave processing on the received transmission signal subjected to the OFDM processing.

5

3. An OFDM communication apparatus equipped with an OFDM transmission apparatus and an OFDM reception apparatus, said OFDM transmission apparatus comprising:

10 a plurality of interleave means capable of executing mutually different interleave processing on a transmission signal;

selecting means for selecting an interleave means to execute interleave processing on said transmission signal from among said plurality of interleave means
15 according to the number of retransmissions of said transmission signal; and

OFDM means for performing OFDM processing on the transmission signal interleaved by the selected interleave means; and

20 said OFDM reception apparatus comprising:

receiving means for receiving a transmission signal performed interleave processing according to the number of retransmissions of the transmission signal by the OFDM transmission apparatus and performing OFDM
25 processing on the received transmission signal;

a plurality of deinterleave means capable of executing mutually different deinterleave processing on the received transmission signal subjected to the OFDM

selecting means for selecting the deinterleave means to execute deinterleave processing corresponding to said interleave processing from among said plurality of deinterleave processing means and allowing the selected interleave means to execute deinterleave processing on the received transmission signal subjected to the OFDM processing.

an OFDM transmission apparatus having:

a plurality of interleave means capable of

15 executing mutually different interleave processing on

a transmission signal;

OFDM means for performing OFDM processing on the transmission signal interleaved by the selected interleave means

25 an OFDM reception apparatus having:

 receiving means for receiving a

transmission signal performed interleave processing

according to the number of retransmissions of the

transmission signal by the OFDM transmission apparatus and performing OFDM processing on the received transmission signal;

a plurality of deinterleave means capable of
 5 executing mutually different deinterleave processing on the received transmission signal subjected to the OFDM processing; and

selecting means for selecting the
 deinterleave means to execute deinterleave processing
 10 corresponding to said interleave processing from among said plurality of deinterleave processing means and allowing the selected interleave means to execute deinterleave processing on the received transmission signal subjected to the OFDM processing.

15

5. A base station apparatus equipped with an OFDM communication apparatus, said OFDM communication apparatus comprising:

an OFDM transmission apparatus having:

20 a plurality of interleave means capable of executing mutually different interleave processing on a transmission signal;

selecting means for selecting an interleave means to execute interleave processing on said
 25 transmission signal from among said plurality of interleave means according to the number of retransmissions of said transmission signal; and

OFDM means for performing OFDM processing on

the transmission signal interleaved by the selected interleave means

an OFDM reception apparatus having:

receiving means for receiving a
5 transmission signal performed interleave processing according to the number of retransmissions of the transmission signal by the OFDM transmission apparatus and performing OFDM processing on the received transmission signal;

10 a plurality of deinterleave means capable of executing mutually different deinterleave processing on the received transmission signal subjected to the OFDM processing; and

selecting means for selecting the
15 deinterleave means to execute deinterleave processing corresponding to said interleave processing from among said plurality of deinterleave processing means and allowing the selected interleave means to execute deinterleave processing on the received transmission
20 signal subjected to the OFDM processing.

6. An OFDM communication method comprising:

an interleave processing step of executing
interleave processing corresponding to the number of
25 retransmissions of a transmission signal from among a plurality of interleave processing on said transmission signal;

a transmitting step of performing OFDM processing

on the transmission signal subjected to the interleave processing and transmitting the transmission signal subjected to the OFDM processing through a transmission path;

- 5 a receiving step of receiving said transmission signal transmitted through said transmission path and performing OFDM processing on the received signal; and
- a deinterleave processing step of executing deinterleave processing corresponding to said executed
- 10 interleave processing from among a plurality of deinterleave processing on the received signal subjected to the OFDM processing.

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T06220 5E90950

ABSTRACT

The OFDM communication apparatus according to the present invention includes a plurality of interleave
5 sections capable of executing mutually different interleave processing on a transmission signal, a selection section for selecting the interleave section to execute interleave processing on the transmission signal from among the plurality of interleave sections
10 and an OFDM section for performing OFDM processing on the transmission signal interleaved by the selected interleave section.

K0620" 4140350

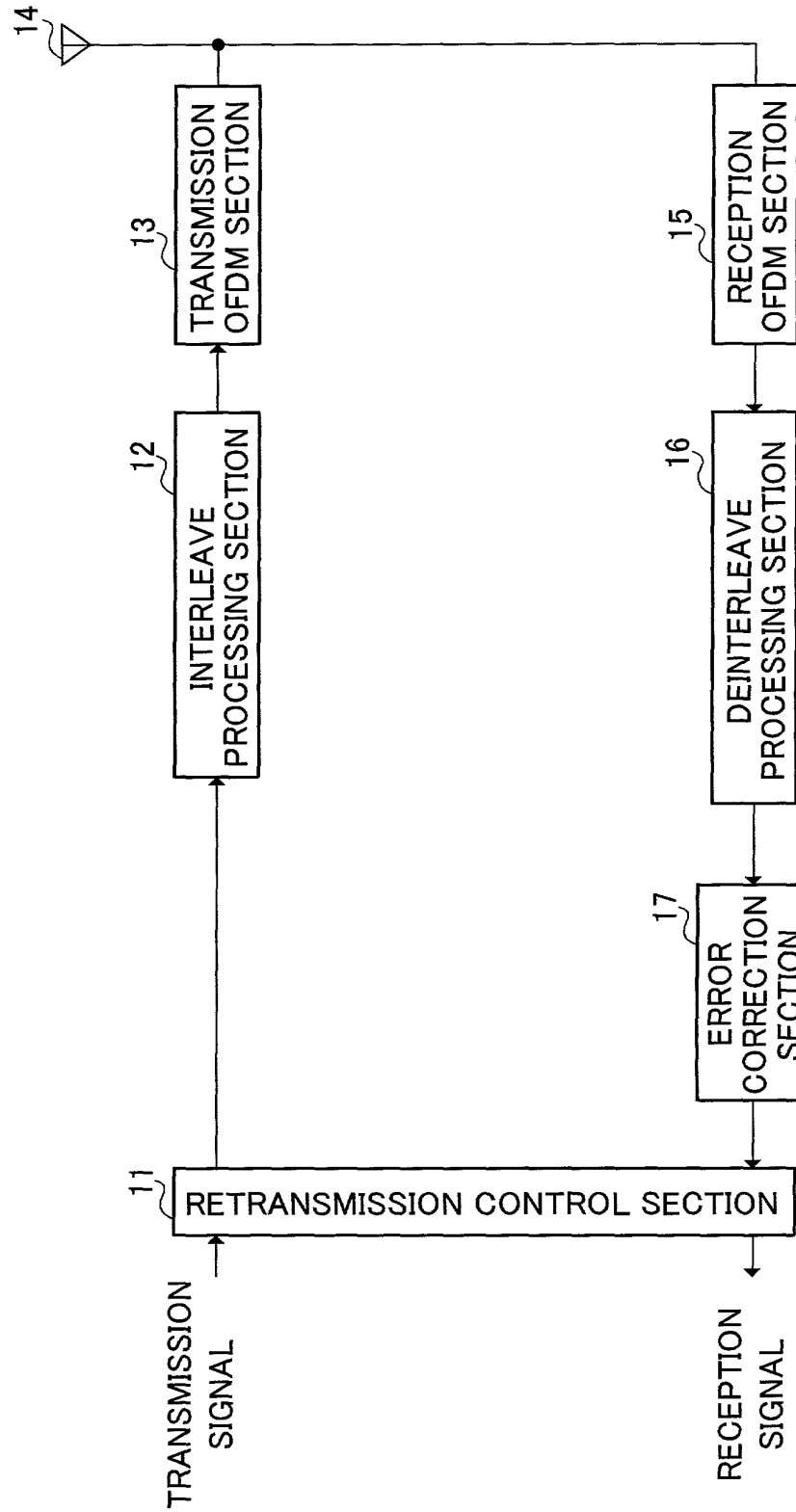
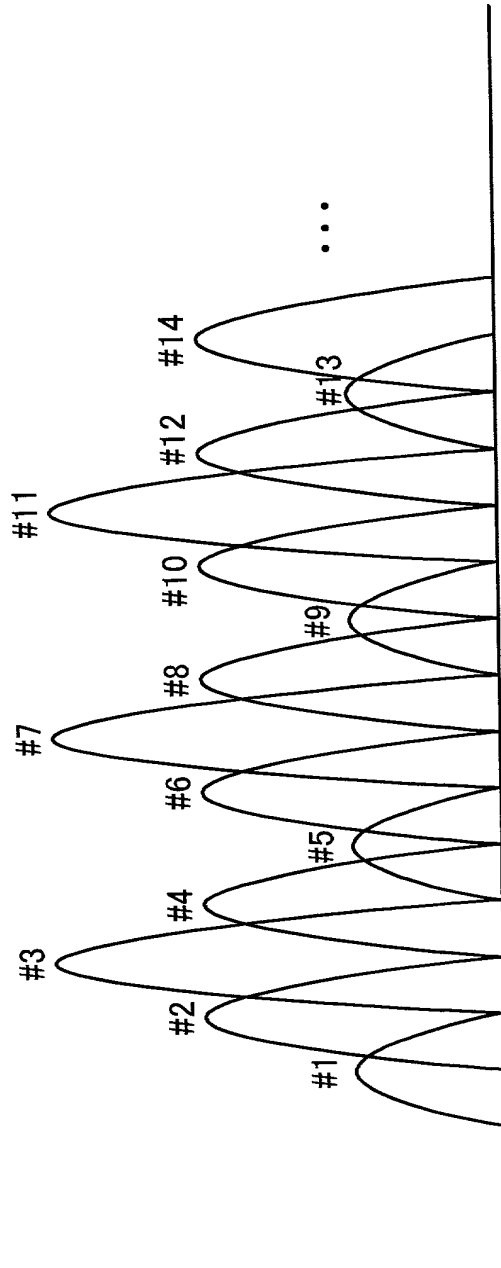


FIG.1



FREQUENCY

FIG.2

3/4

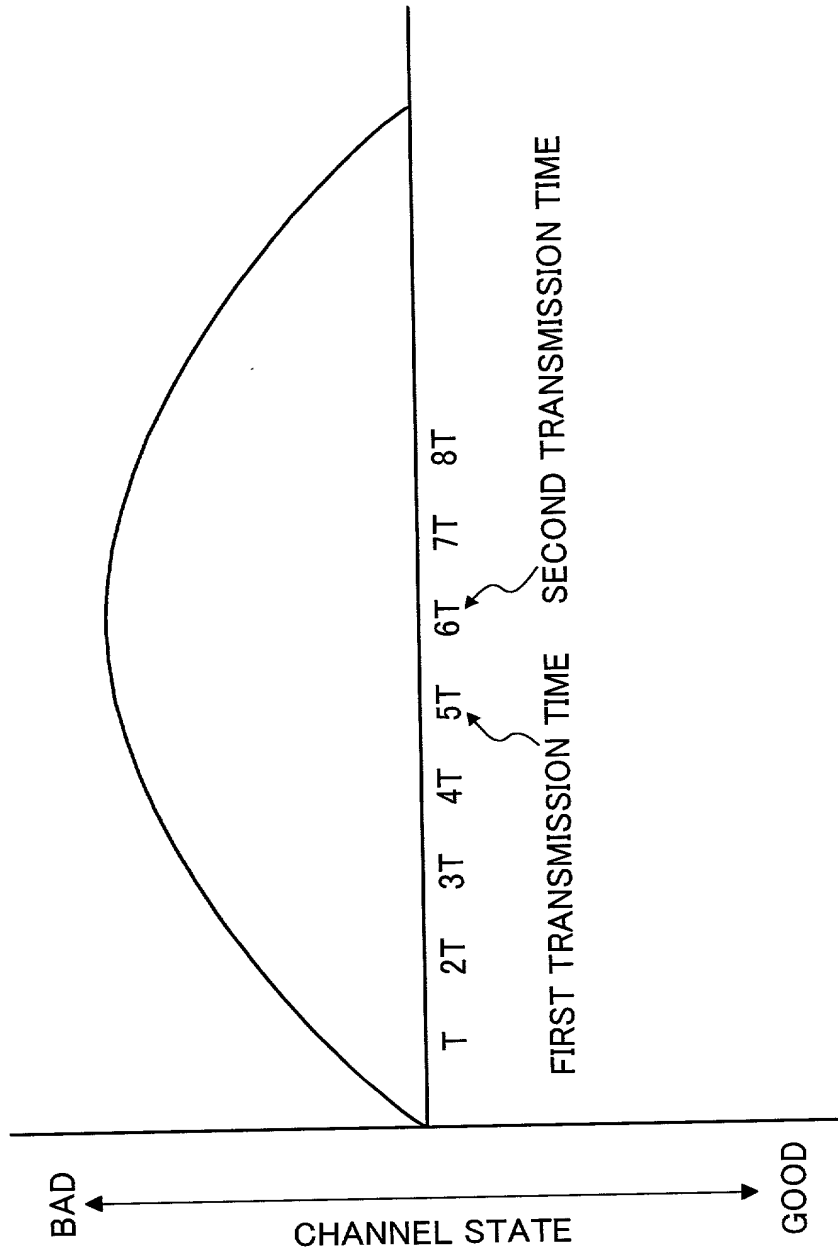


FIG.3

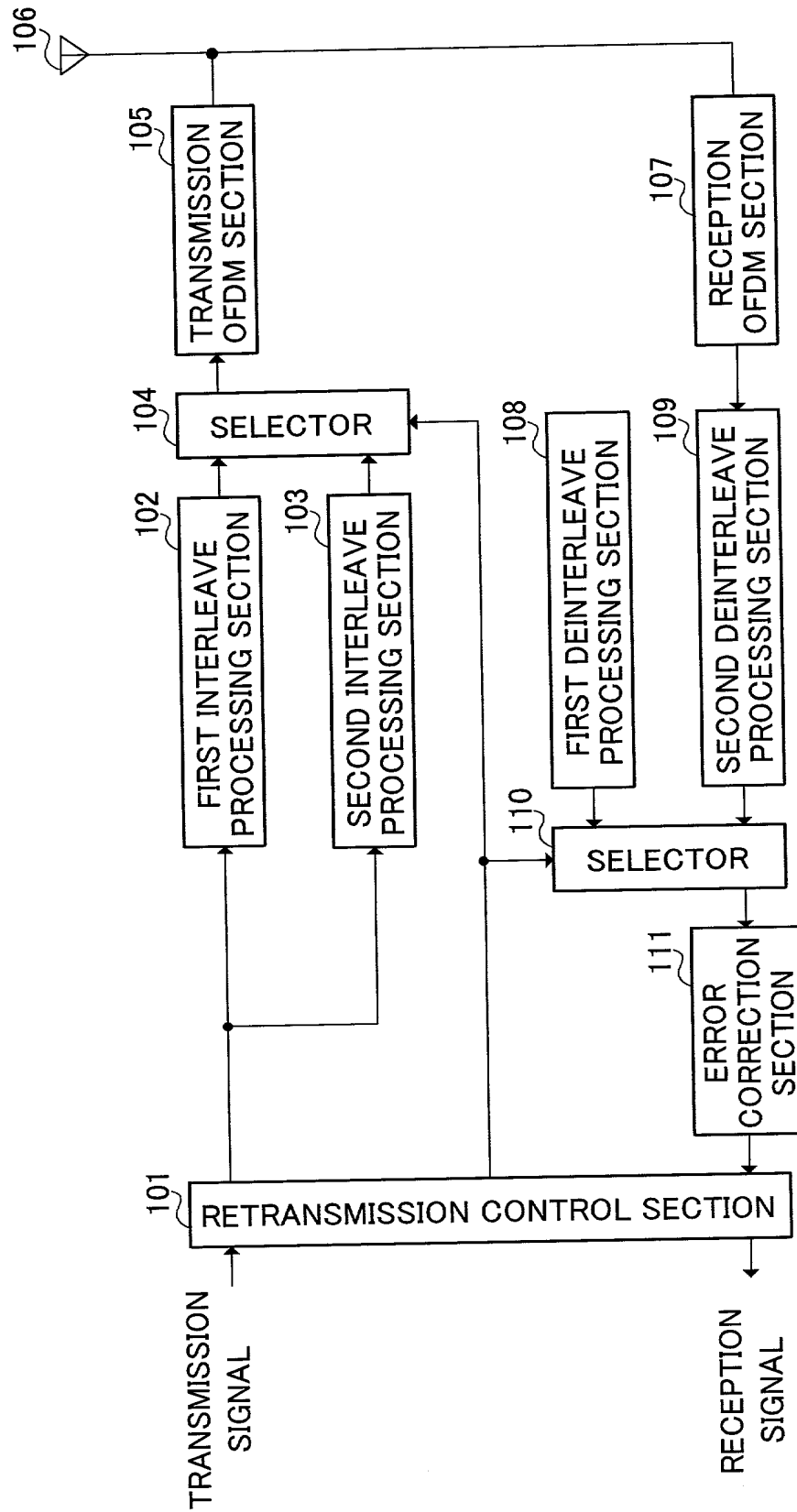


FIG. 4

APPLICATION FOR UNITED STATES PATENT
Declaration for Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: OFDM COMMUNICATION APPARATUS

the specification of which 2 (file no _____)

(check at least one) 3 ☒ is attached hereto

4 ☐ was filed on _____ as (5) U.S. Application Serial No. _____

6 ☐ and was amended _____
(if applicable)

Use this 7 ☒ was filed as PCT international application
portion
only if you
are entering
the U.S.
National
phase based
on a PCT
International
Application
designating
the U.S.

8 Number PCT/JP00/04969

9 on July 26, 2000

and was amended under PCT Article(s) 19 and/or 34

10 on _____ (if applicable).

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application (s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. 119

Priority Claimed

11a JAPAN JP11-233909 20/August/1999 ☒ ☐
(Country) (Number) (Day/Month/Year Filed) Yes No

_____ _____ _____ ☐ ☐
(Country) (Number) (Day/Month/Year Filed) Yes No

☐ Additional foreign application numbers are listed on a supplemental priority data sheet attached hereto.

Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

11b _____
Application No. Day/Month/Year Filed Application No. Day/Month/Year Filed

Do not use this
portion to identify a
PCT application if the
parent application is
the U.S. National
phase of the PCT
application

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application.

13 _____
(U.S. Application Number) (U.S. Filing Date) Status (patented, pending, abandoned)

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

3 James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO
STEVENS, DAVIS, MILLER & MOSHER, L.L.P., 1615 L Street, N.W., Suite 850, Washington, D.C. 20036,
TELEPHONE (202) 408-5100, FACSIMILE (202) 408-5200.

See page 2 for signature lines

INSTRUCTIONS FOR COMPLETION OF THIS FORM

- line 1 Insert the same title as is used on the specification and in the assignment.
- line 2 Is optional but is provided so that you can use it to identify more readily an application prior to the time that the Patent Office application serial number is assigned. We suggest that the specification, drawings and declaration always bear a file number since it can help to get the papers together in case they become inadvertently separated. In instances where the specification is filed without a signed declaration form (under 37 CFR §1.53) a file number on a later-received separate form will assist us in associating it with the correct case.
- line 3 Check this box if the specification, claims and drawing (if any) are attached to this declaration form, e.g., when filing a new patent application.
- lines 4-5 Are only used in an instance where the application is already on file and the declaration from is being separately filed, e.g., when the application was originally filed without a signed declaration or where the Patent Office has required a new declaration because of a deficiency in the original declaration. In such an instance the Patent Office will require that lines 4 and 5 be completed with the filing date and application serial number already assigned.
- line 6 Is used in conjunction with line 5 but only when there have been one or more amendments to the specification or claims. Line 6 is also used when the Examiner requires a new declaration because claims inserted by amendment cover subject matter not originally claimed (37 CFR §1.67).
- lines 7-10 Are for PCT (Patent Cooperation Treaty) cases and are used only when you are entering the U.S. National phase (Chapter I or II) based upon a previously filed PCT International application designating the U.S.
- line 7 Check this box if this is a PCT National Phase application.
- line 8 Insert PCT International application number.
- line 9 Insert date of filing of PCT International application.
- lines 10 Insert the date of all amendments filed in the PCT International application. Such amendments are optional, so this line at times will not be used.
- line 11a Is used in the following instances:
- (i) If a single priority is being claimed from a foreign application you need to list only the first-filed application; you do not need to list other countries if all applications were filed within one year of the U.S. filing.
 - (ii) If multiple priorities are being claimed, from a plurality of applications filed in one or more countries, you must list the first filed application for each aspect of the invention. Example: if aspect A of the invention was disclosed in an application filed 11 months earlier in country X and aspect B was disclosed 9 months earlier in an application filed in country Y, then the applications in both countries X and Y must be identified. Only the first application for each aspect of the invention needs to be identified provided all applications on that aspect were filed within one year prior to the U.S. filing.
 - (iii) If a non-priority application is being filed you must list all applications in all countries where corresponding foreign applications were filed more than one year prior to the U.S. filing. This is so the Examiner can check to see if any of those applications were published or patented early enough to be prior art against the U.S. application.
 - (iv) If there are more than two applications to be listed we suggest that you type in on this form only "See attached Schedule A" and then list all of the previous applications on an attached sheet.
- line 11b Is used to claim priority under 35 USC §119(e) based on a provisional application filed within one year of the filing of the instant application. More than one provisional application may be identified provided neither was filed more than one year earlier.
- line 12 This block is used only in instances where there is a previously filed U.S. non-provisional application which was copending at the time the present application was (or is being) filed. That previous application could be a U.S. non-provisional application or the National Phase of a PCT allocation. In such a case the present application may be entitled to the priority of the previous application's U.S. filing date (and consequently the foreign priority thereof) provided the present application is identified as a continuing application (continuation, divisional or continuation-in-part) of the earlier (parent) application. If the foregoing is applicable, please fill in one line for each such prior application.
- line 13 Type the inventor's proper legal name in the order specified, e.g., "John B. JONES" or "J. Bob JONES" if the inventor so prefers. It is not acceptable to use only initials such as "J. B. JONES."
- line 14 The inventor's "signature" may be his (or her) usual manner of signing but it is preferable that the inventor simply write his (or her) name in his (or her) own cursive handwriting in the same order as on line 14, e.g., given name, middle initial and family name.
- line 15 Insert the actual date of signature.
- line 16 Insert simply the city and state or country, e.g., "Paris, France", of the inventor's residence, not citizenship. No street address or postal code is required on this line.
- line 17 Insert the inventor's citizenship. The statement of citizenship (or subject of) is a statutory requirement (35 USC §115). Simply the name of the country of citizenship, e.g., "Japan" is sufficient.
- line 18 Insert the inventor's mailing address. The purpose of requiring the post office address is to enable the Patent Office to communicate directly with the inventor if desired, such as in the case of death of the U.S. attorney. It should be the address where the inventor customarily receives his (or her) mail and should include the postal code. If applicable it can be the inventor's business address or address at place of employment.

Applicants are reminded that the U.S. Patent and Trademark Office has very strict requirements as to proper execution of an application. The applicant should make sure that he reviews the declaration, prior to signing to make sure the declaration properly identifies the application and all relevant information; and should review the specification and claims (including drawings, if any) before signing the declaration. Failure to do so will require the filing of a supplemental declaration --- 37 CFR §1.67(c).

Any handwritten changes to the specification, claims or drawings must be in ink personally by all of the inventors prior to signing the declaration and the adjacent left margin must be initialed and dated by all of the inventors, e.g., "JB 6-9-91".

Please let us know if there are any questions regarding proper completion of this form. Thank you.

An assignment, a separate document requiring separate signature and dating may be enclosed. Please look for it and sign and date it in the same manner as in lines 15 and 16 above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

PAGE 2 OF U.S.A. DECLARATION FORM

13a	Typewritten Full Name of Sole or First Inventor	100	<u>Hiroaki</u>	<u>SUDO</u>
			Given Name	Family Name
14a	Inventor's Signature		<u>Hiroaki</u>	<u>Sudo</u>
15a	Date of Signature		<u>February</u>	<u>19</u> <u>2001</u>
			Month	Day Year
16a	Residence		<u>Yokohama-shi</u>	<u>Kanagawa</u> <u>JAPAN</u>
			City	State or Province Country
17a	Citizenship		<u>JAPAN</u>	
18a	Post Office Address (Insert complete mailing address, including country)		<u>508, Saedo-cho, Tsuzuki-ku,</u> <u>Yokohama-shi, Kanagawa 224-0054 JAPAN</u>	
13b	Typewritten Full Name of Sole or First Inventor		Given Name	Middle Name Family Name
14b	Inventor's Signature			
15b	Date of Signature		Month	Day Year
16b	Residence		City	State or Province Country
17b	Citizenship			
18b	Post Office Address (Insert complete mailing address, including country)			
13c	Typewritten Full Name of Sole or First Inventor		Given Name	Middle Name Family Name
14c	Inventor's Signature			
15c	Date of Signature		Month	Day Year
16c	Residence		City	State or Province Country
17c	Citizenship			
18c	Post Office Address (Insert complete mailing address, including country)			
13d	Typewritten Full Name of Sole or First Inventor		Given Name	Middle Name Family Name
14d	Inventor's Signature			
15d	Date of Signature		Month	Day Year
16d	Residence		City	State or Province Country
17d	Citizenship			
18d	Post Office Address (Insert complete mailing address, including country)			